NOVEL APPLICATIONS OF SPACE TIME PROCESSING FOR WIRELESS SYSTEMS

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ABSTRACT

Space-time processing techniques have emerged as one of the most promising areas of research and development in wireless communications. Space-time processing signifies the signal processing performed on a system consisting of several antenna elements, whose signals are processed adaptively in order to exploit both the spatial (space) and temporal (time) dimensions of the radio channel. Space-time processing techniques can be applied at the transmitter, the receiver or both. The use of space-time signal processing can significantly improve average signal power, mitigating fading, and reduce inter-symbol interference and co-channel interference. This can significantly improve capacity, coverage and quality of wireless systems.

In this thesis we expand the scope of space-time processing by proposing novel applications in wireless communications. These include the reduction of possibly harmful electromagnetic radiation from mobile phones, enhancing link quality for Bluetooth links in indoor office environments, and increasing the spectral efficiency of satellite communication systems.

Several studies have been conducted on the effects of radiation from hand held mobile phones. The amount of radiation emitted from most mobile phones is minute, but given the close proximity of the phone to the head it might be possible for the radiation to cause harm. In Part I, we suggest the use of adaptive signal processing algorithms combined with a MIMO (multiple-input multiple-output) antenna system to decrease the electromagnetic radiation inside a certain volume in space (e.g. at the human head). In addition, we investigate the impact of MIMO antenna parameters, carrier frequency and power constraint on the performance of the system.

Over the last decade there has been an explosive growth in the use of wireless mobile communications. Today we find users with mobile phones, wireless PDA's, MP3 players, and wireless headphones to connect to these devices. In Part II, we investigate the wave propagation effects of a short-range wireless device, such as the Bluetooth technology. Specifically, we assess the fading phenomenon for Bluetooth link in indoor office environment by simulation of different propagation scenarios, and use measurement results to confirm our findings. In addition, we investigate the improvement in performance resulting from receiver diversity gain of a system employing multiple receive antennas with various combining techniques.

The need for high-speed, high-quality bandwidth efficient mobile communications is constantly increasing. In Part III, we address the potential gain of using MIMO antenna system in combination with OFDM (orthogonal frequency division multiplexing) in order to increase the bandwidth efficiency in satellite communication systems. In particular, we consider the increase in channel capacity that is possible by exploiting satellite and polarization diversity. In addition, we investigate the effect of using different compact MIMO polarization antenna configurations and power control on the information theoretic capacity of the total transmission channel of the satellite system.

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